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Li et al.

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(54) **AUTONOMOUS COVERAGE VACUUM CLEANER HAVING ROLLER BRUSH CAPABLE OF RESILIENT VERTICAL DISPLACEMENT AND ROLLER BRUSH FRAME UNIT FOR THE SAME**

(71) Applicant: **EGENPOWER INC.**, Laguna Niguel, CA (US)

(72) Inventors: **Gary Li**, Dong Guan (CN); **Sheng-Chan Chiu**, Burnaby (CA)

(73) Assignee: **Egenpower Inc.**, Laguna Niguel, CA (US)

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(51) **Int. Cl.**

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A47L 9/04	(2006.01)
A47L 9/06	(2006.01)
A47L 5/34	(2006.01)
A47L 11/40	(2006.01)

(52) **U.S. Cl.**

CPC ***A47L 9/0494*** (2013.01); ***A47L 5/34*** (2013.01); ***A47L 11/4058*** (2013.01); *A47L 11/4041* (2013.01); *A47L 2201/00* (2013.01)

(58) **Field of Classification Search**

CPC A47L 5/34; A47L 9/0494; A47L 2201/00; A47L 11/4058

USPC 15/371, 368

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,416,420	A *	2/1947	Taylor	15/372
4,976,003	A *	12/1990	Williams	15/372
6,581,239	B1 *	6/2003	Dyson et al.	15/340.3
6,934,993	B1 *	8/2005	Huffman et al.	15/322
7,200,892	B2 *	4/2007	Kim	15/319
8,166,608	B2 *	5/2012	Becker et al.	15/372
2012/0169497	A1 *	7/2012	Schnittman et al.	340/540

FOREIGN PATENT DOCUMENTS

DE 102010000577 A1 * 8/2011

* cited by examiner

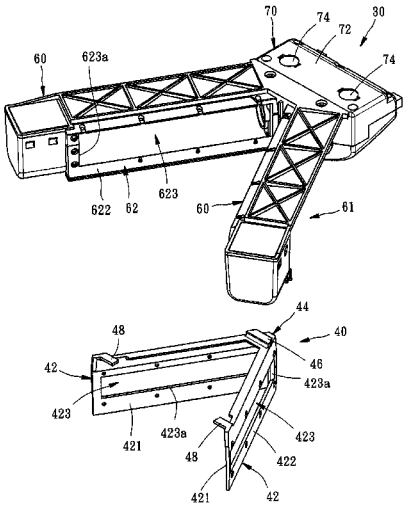
Primary Examiner — Bryan R Muller

(74) *Attorney, Agent, or Firm* — Muncy, Geissler, Olds & Lowe, P.C.

(57) **ABSTRACT**

Provided are an autonomous coverage vacuum cleaner and a roller brush frame unit for use therewith. The autonomous coverage vacuum cleaner includes a body, the roller brush frame unit, and at least a roller brush. The roller brush frame unit includes a roller brush frame, a connection frame, and a resilient connection element. The connection frame is disposed at a bottom of the body. The resilient connection element is connected between the roller brush frame and the connection frame. The roller brush frame moves vertically relative to the connection frame and the body when subjected to an external force. The roller brush is rotatably disposed at the roller brush frame. The roller brush frame unit enables the roller brush of the autonomous coverage vacuum cleaner to lift and drop resiliently and automatically according to the condition of the floor.

8 Claims, 7 Drawing Sheets



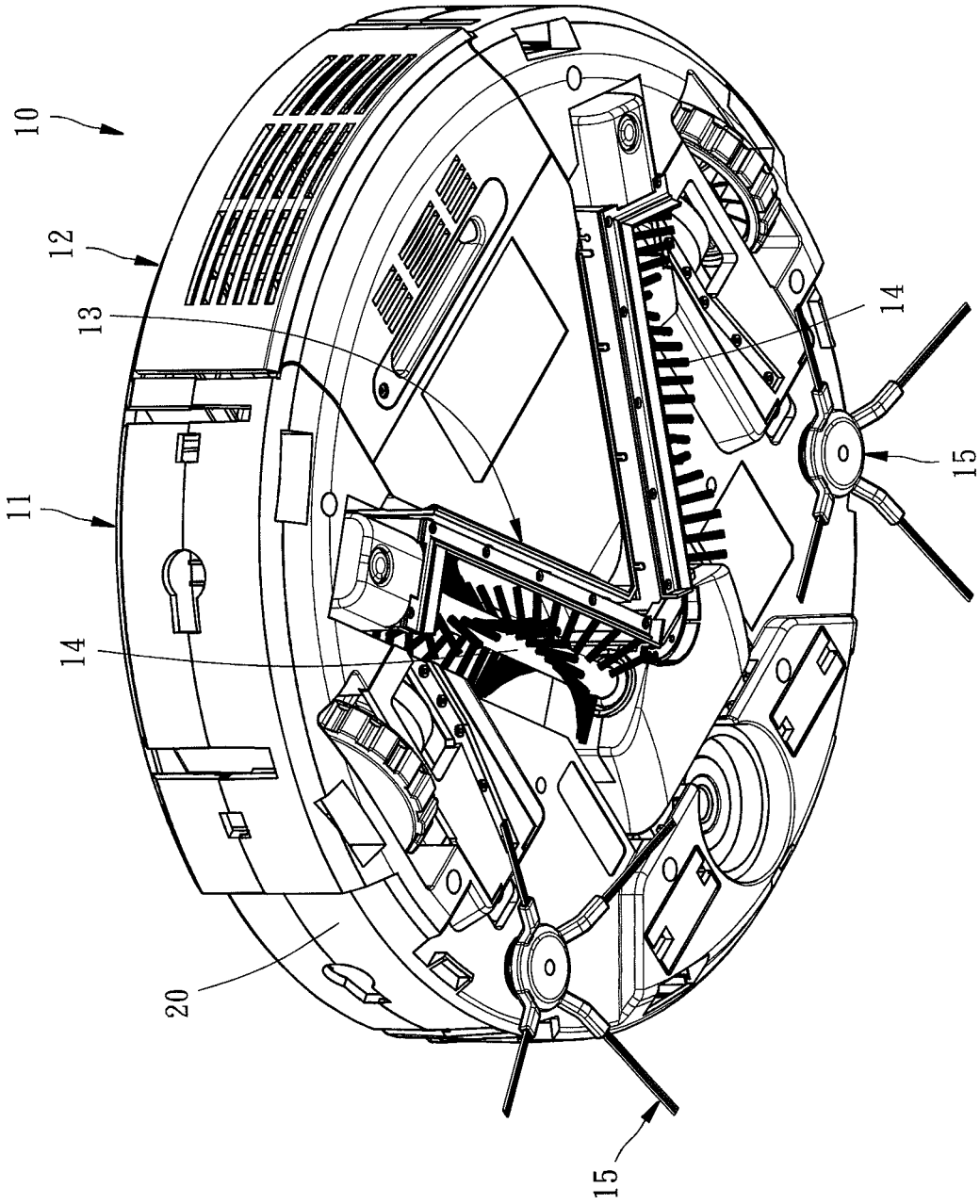


FIG. 1

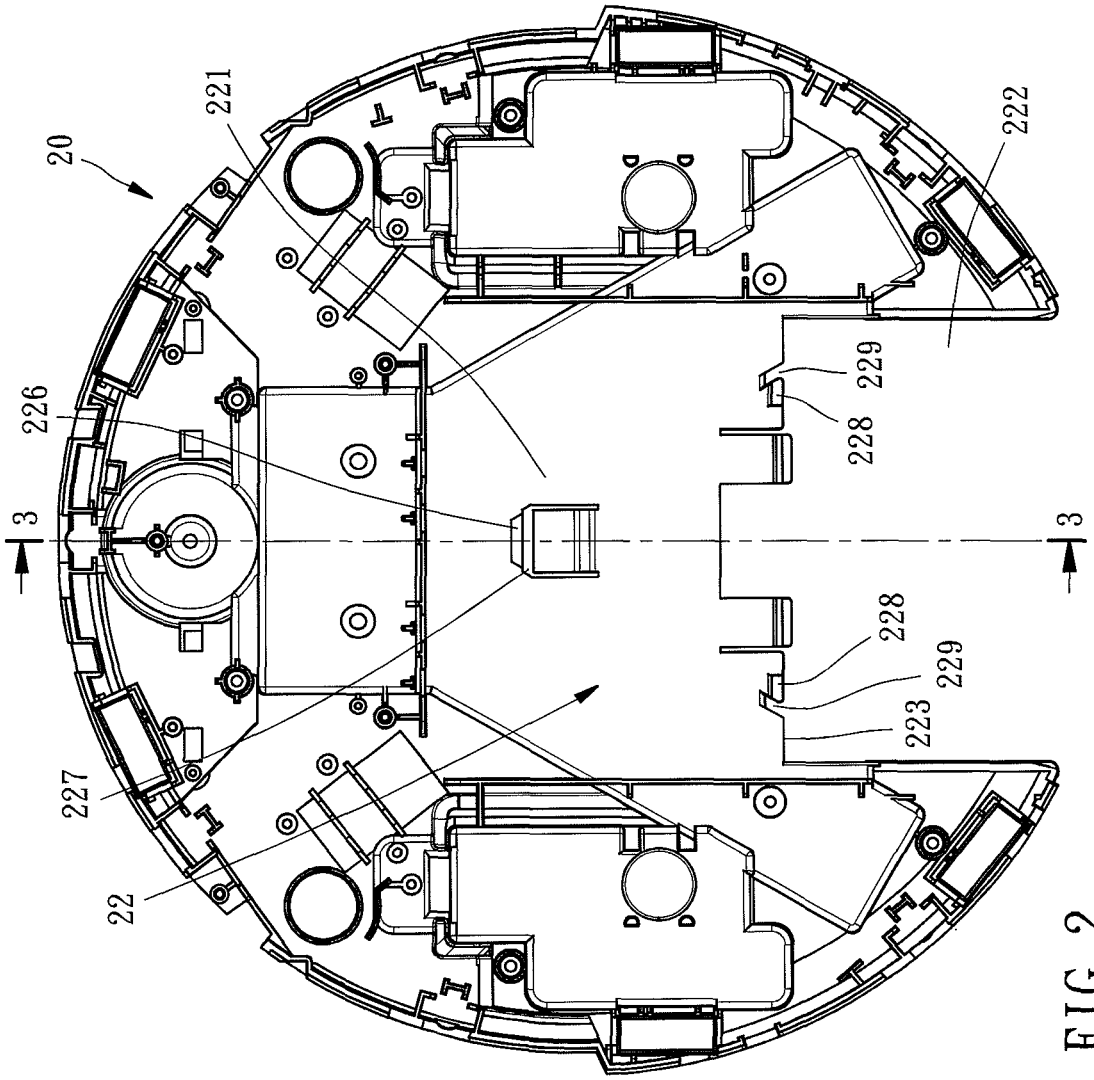


FIG. 2

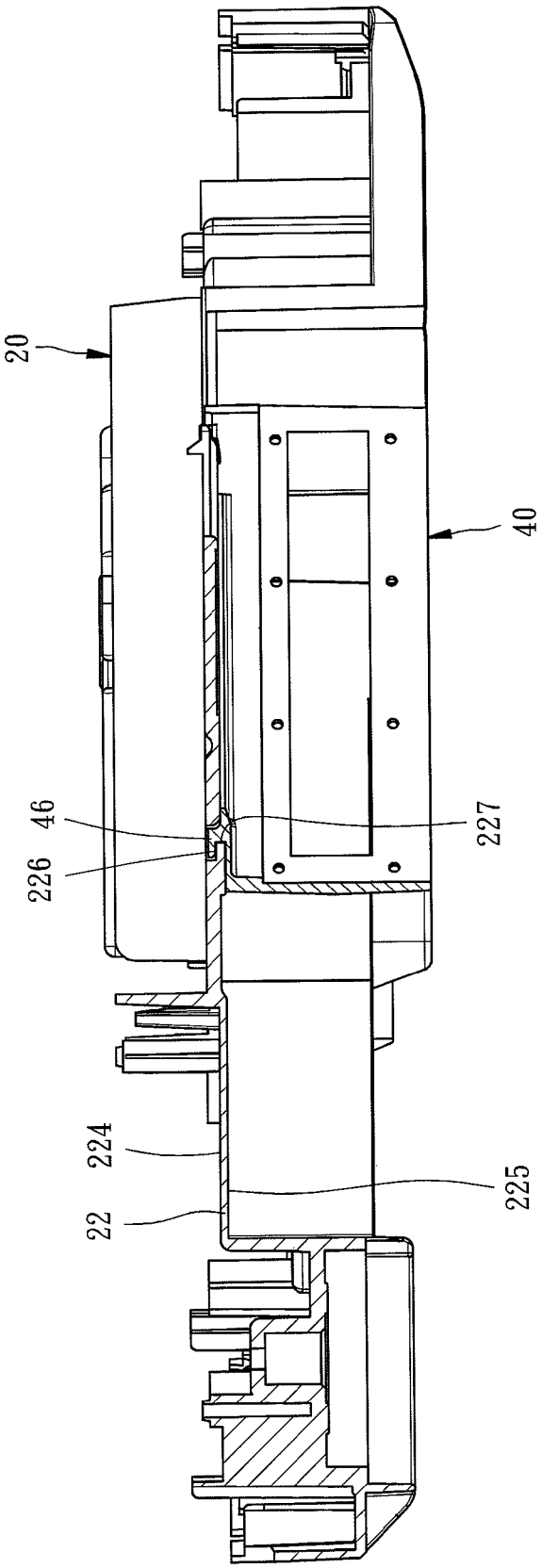


FIG. 3

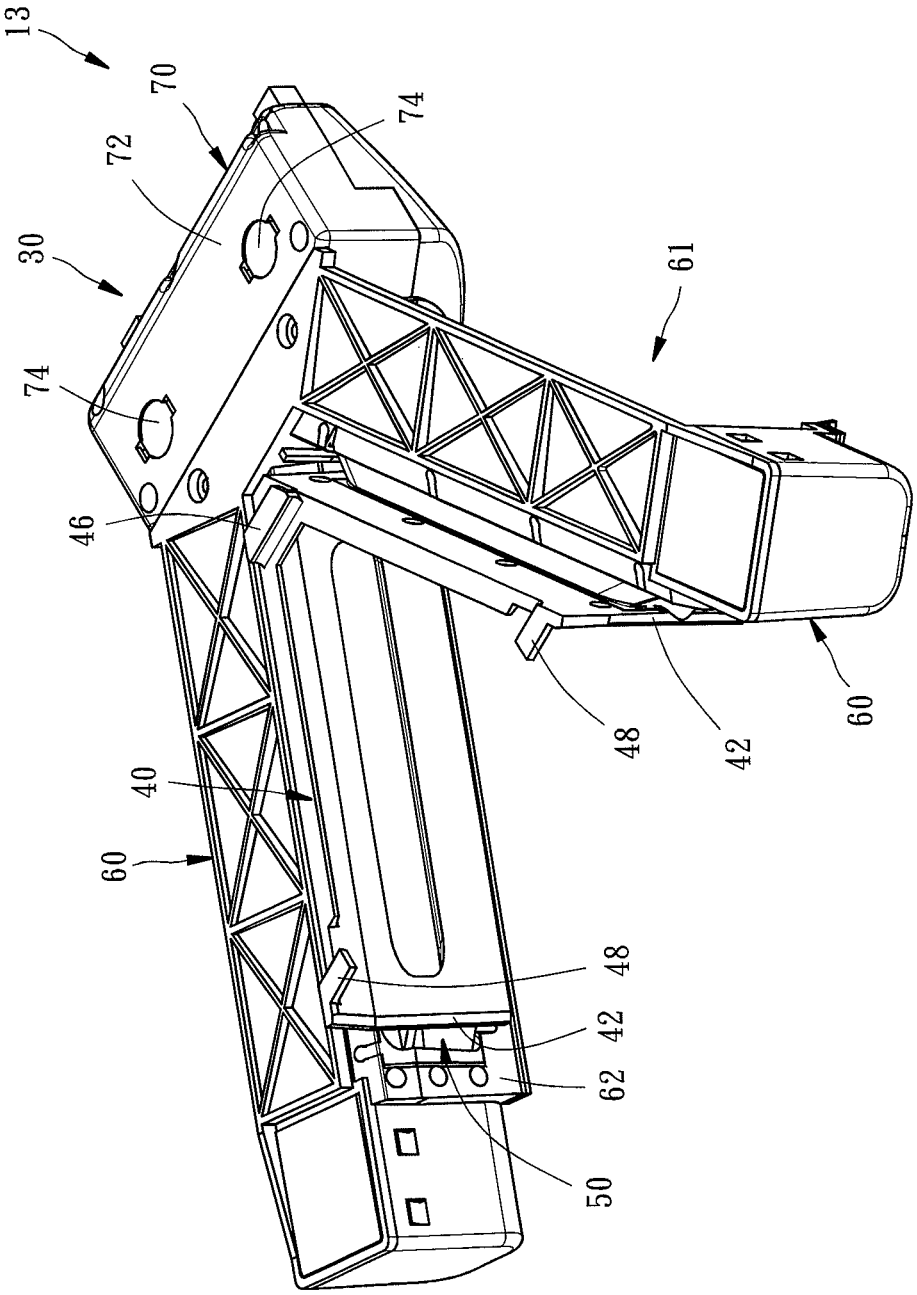


FIG. 4

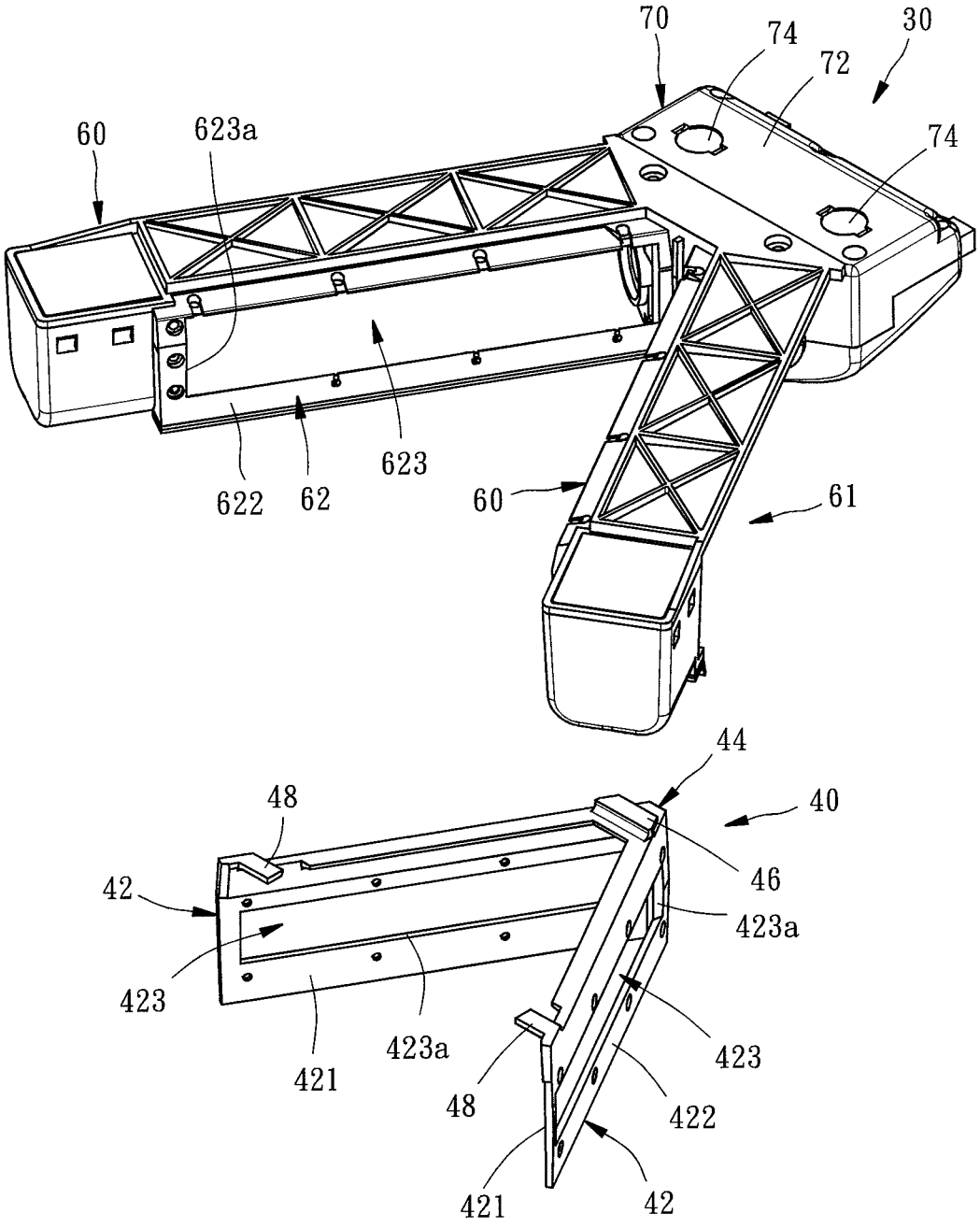

70
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FIG. 5

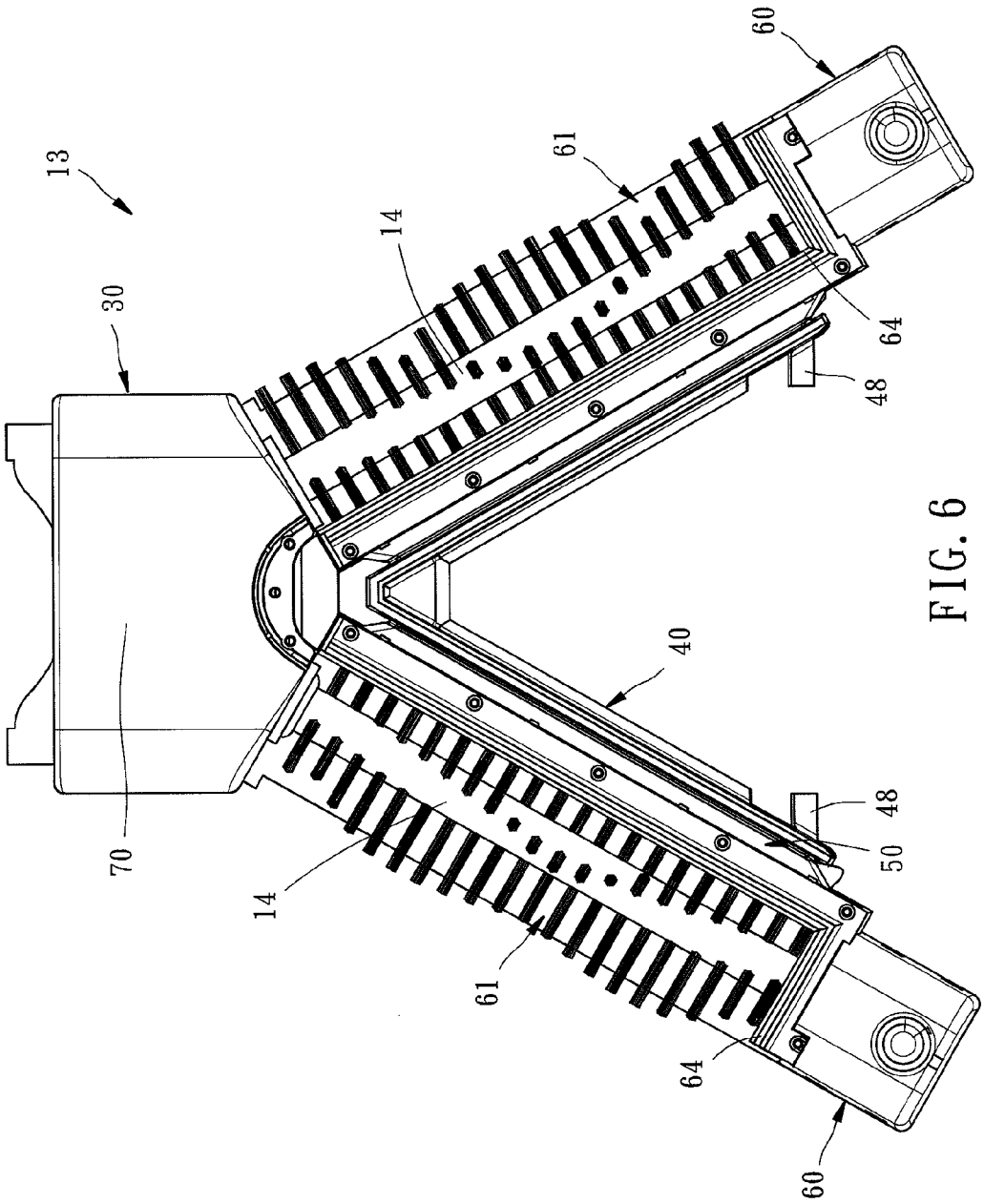

FIG. 6

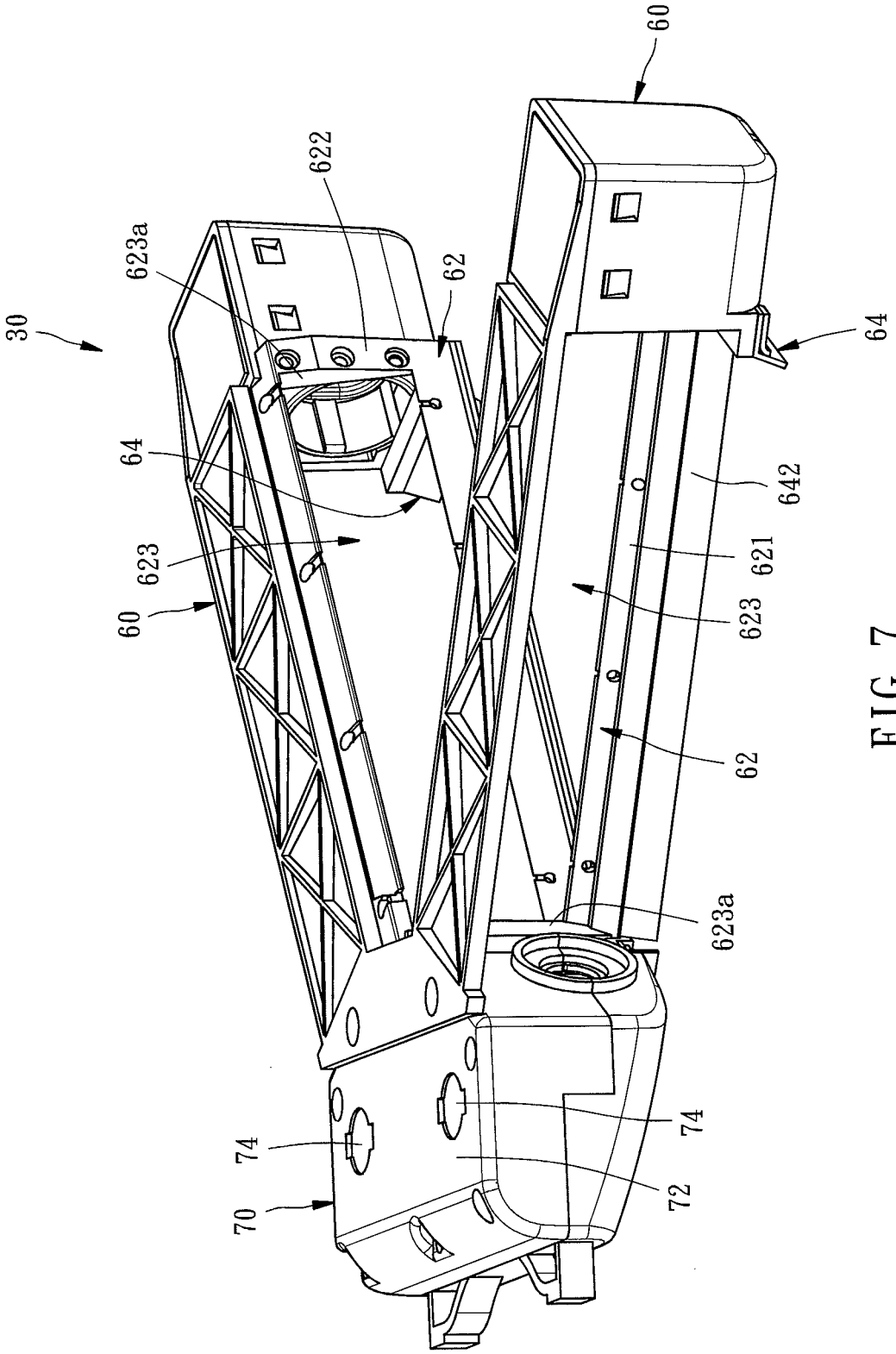

FIG. 7

AUTONOMOUS COVERAGE VACUUM CLEANER HAVING ROLLER BRUSH CAPABLE OF RESILIENT VERTICAL DISPLACEMENT AND ROLLER BRUSH FRAME UNIT FOR THE SAME

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates to autonomous coverage vacuum cleaners, and more particularly, to an autonomous coverage vacuum cleaner having a roller brush capable of resilient vertical displacement and a roller brush frame unit for the same.

2. Description of Related Art

During its autonomous journey, a conventional autonomous coverage vacuum cleaner gathers dust and debris from the floor with a roller brush disposed at its bottom and rotating about an axle mounted on the bottom and positioned parallel to the floor, wherein the dust and debris is sucked into a vacuum cleaning apparatus and then collected by a dust-collecting apparatus. The roller brush of the conventional autonomous coverage vacuum cleaner is rotatably disposed at a roller brush frame. The roller brush frame is fixedly disposed at a body of the autonomous coverage vacuum cleaner. As a result, the roller brush can only rotate but cannot move relative to the body.

In case a floor is uneven or has an obstacle, the roller brush, which comes into contact with the floor inevitably, is likely to be confronted with hindrance to thereby prevent the autonomous coverage vacuum cleaner from moving smoothly. For instance, the autonomous coverage vacuum cleaner is seldom able to cross the edge of a carpet, and thus the autonomous coverage vacuum cleaner is unable to move onto the carpet and may even come to a halt. Even if the autonomous coverage vacuum cleaner manages to move onto the carpet, the aforesaid hindrance will prevent the edge of the carpet from being thoroughly cleaned.

SUMMARY OF THE INVENTION

In view of the aforesaid drawbacks of the prior art, it is an objective of the present invention to provide an autonomous coverage vacuum cleaner and a roller brush frame unit for use with the autonomous coverage vacuum cleaner. The roller brush frame unit enables a roller brush of the autonomous coverage vacuum cleaner to lift and drop resiliently and automatically according to the condition of the floor and thereby the passage and cleaning performance of the autonomous coverage vacuum cleaner.

In order to achieve the above and other objectives, the present invention provides an autonomous coverage vacuum cleaner having a roller brush capable of lifting and dropping resiliently. The autonomous coverage vacuum cleaner comprises a body, a roller brush frame unit, and at least a roller brush. The roller brush frame unit comprises a roller brush frame, a connection frame, and a resilient connection element. The connection frame is disposed at the bottom of the body. The resilient connection element is connected between the roller brush frame and the connection frame, such that the roller brush frame moves vertically relative to the connection frame and the body when subjected to an external force. The roller brush rotatably disposed at the roller brush frame

Accordingly, the roller brush is connected to the body by means of the roller brush frame unit, such that the autonomous coverage vacuum cleaner in operation can come into contact with a floor and perform a cleaning operation thereon.

If the autonomous coverage vacuum cleaner works on an uneven floor or is confronted with an obstacle, an external force exerted by the floor or the obstacle on the roller brush will be indirectly transmitted to the roller brush frame. With the roller brush frame being capable of moving vertically relative to the connection frame and the body because of the resilience of the resilient connection element, the roller brush can lift and drop in order to fit the uneven surface of the floor. Therefore, the roller brush is not only capable of passing an obstacle easily, but is also capable of cleaning thoroughly a location which might otherwise not be accessible. Hence, the roller brush frame unit enables a roller brush of the autonomous coverage vacuum cleaner to lift and drop resiliently and automatically according to the condition of the floor and thereby enhances the passage and cleaning performance of the autonomous coverage vacuum cleaner.

Detailed structures, features, assembly, and operation of an autonomous coverage vacuum cleaner having a roller brush capable of resilient vertical displacement and a roller brush frame unit for the same, which are provided by the present invention, are illustrated with embodiments hereunder. However, persons skilled in the art are able to understand that the detailed description and specific embodiments below are illustrative of the present invention, rather than restrictive of the claims of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective assembled view of an autonomous coverage vacuum cleaner having a roller brush capable of lifting and dropping resiliently according to a preferred embodiment of the present invention;

FIG. **2** is a top view of a lower casing of the autonomous coverage vacuum cleaner according to the preferred embodiment of the present invention;

FIG. **3** is a cross-sectional view of the lower casing taken along line **3-3** of FIG. **2**, showing that a connection frame disposed at the lower casing;

FIG. **4** is a perspective assembled view of a roller brush frame unit according to the preferred embodiment of the present invention;

FIG. **5** is a perspective disassembled view of the roller brush frame unit according to the preferred embodiment of the present invention, wherein a resilient connection element of the roller brush frame unit is removed for the sake of illustration;

FIG. **6** is a bottom view of the roller brush frame unit and two roller brushes according to the preferred embodiment of the present invention; and

FIG. **7** is a perspective view of a roller brush frame of the roller brush frame unit according to the preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. **1**, in a preferred embodiment of the present invention, an autonomous coverage vacuum cleaner **10** comprises a body **11**, a dust-sucking and dust-collecting apparatus **12** disposed at a bottom of the body **11**, two roller brush frame units **13** which flank the dust-sucking and dust-collecting apparatus **12**, two roller brushes **14** rotatably disposed at the roller brush frame units **13**, respectively, and two edge cleaning heads **15** partially protruding from the body **11**.

The body **11** is not only capable of moving across the floor in an automated manner, but is also capable of detecting an obstacle and thus turning aside automatically. The edge

cleaning heads **15** sweep dust and debris from the portion of the floor which lies at the periphery of the body **11** to thereby sweep the dust and debris to the space between the body **11** and the floor, while the body **11** is moving. With the roller brushes **14**, the dust and debris between the body **11** and the floor is swept upward. The dust-sucking and dust-collecting apparatus **12** sucks and collects the dust and debris. The essential technical features of the present invention are attributed to the roller brush frame units **13** as well as the junction of the body **11** and the roller brush frame units **13**, and thus the other components of the present invention are not described in detail herein.

The body **11** comprises a lower casing **20** shown in FIG. **1** through FIG. **3**. The lower casing **20** has a bottom board **22**. The bottom board **22** has a central area **221**, a hollowed-out area **222** where the dust-sucking and dust-collecting apparatus **12** is positioned, and an edge **223** defining the hollowed-out area **222**. Furthermore, the bottom board **22** has an upper surface **224**, a lower surface **225**, a first recess **226** positioned at the central area **221** and dented from the upper surface **224**, a first groove **227** disposed at the central area **221** and penetrating the upper and lower surfaces **224**, **225**, two second recesses **228** disposed at the edge **223** and dented from the upper surface **224**, and two second grooves **229** disposed at the edge **223** and penetrating the upper and lower surfaces **224**, **225**. The first recess **226** is in communication with the first grooves **227**. The two second recesses **228** are in communication with the two second grooves **229**.

Referring to FIG. **4** through FIG. **6**, the roller brush frame unit **13** comprises a roller brush frame **30**, a connection frame **40**, and a resilient connection element **50** connected between the roller brush frame **30** and the connection frame **40**.

The roller brush frame **30** has two receiving portions **60** and a driving portion **70** disposed at the junction of the two receiving portions **60**. The receiving portions **60** have a receiving space **61** each. A roller brush **14** is disposed in each of the receiving spaces **61**. Two ends of each of the roller brushes **14** are disposed at the receiving portions **60** and the driving portion **70**, respectively. A motor (not shown) for driving the two roller brushes **14** to rotate is disposed in the driving portion **70**. The driving portion **70** has two conductive elements **74** exposed from a top surface **72** of the driving portion **70** and electrically connected to the motor. Furthermore, referring to FIG. **5** and FIG. **7**, the receiving portions **60** each have a vertical plate **62**. The vertical plates **62** each have an inner surface **621**, an outer surface **622**, and a through hole **623** penetrating the inner and outer surfaces **621**, **622**. The inner surface **621** faces the receiving space **61** of a corresponding one of the receiving portions **60**. Furthermore, a guiding member **64** is disposed beneath each of the receiving portions **60**. The guiding member **64** has an inclined surface **642** facing the receiving space **61**. The inclined surface **642** tilts toward the receiving space **61** in a top-down direction. Hence, once the roller brushes **14** are disposed at the receiving space **61**, the inclined surface **642** will face the roller brushes **14** and tilt toward the roller brushes **14** in a top-down direction.

The connection frame **40** has two vertical plates **42**. The vertical plates **42** each have an inner surface **421**, an outer surface **422**, and a through hole **423** penetrating the inner and outer surfaces **421**, **422**. The two vertical plates **42** join each other with one end thereof to form a joint portion **44**. A first engaging hook **46** is disposed at the joint portion **44**. A second engaging hook **48** is disposed at each of the two vertical plates **42**.

The resilient connection element **50** is formed from rubber by a heating and curing process, and gets connected between the roller brush frame **30** and the connection frame **40** when cured. The outer surface **622** of the vertical plates **62** of the roller brush frame **30** and the outer surface **422** of the vertical plates **42** of the connection frame **40** face each other and are spaced apart from each other by a distance. The resilient connection element **50** is mostly formed between the roller brush frame **30** and the connection frame **40** and is partially adhered and fixed to hole walls **623***a*, **423***a* of the through holes **623**, **423**, the inner surfaces **621**, **421**, and the outer surfaces **622**, **422** of the vertical plates **62**, **42**, respectively.

The roller brush frame unit **13** is fixedly disposed at the bottom of the body **11** by means of the connection frame **40** in a manner that the first engaging hook **46** is penetratingly disposed at first grooves **227** of a bottom board **22** of the body **11**, engagedly disposed at the first recess **226** (as shown in FIG. **3**), penetratingly disposed at the two second grooves **229**, and engagedly disposed at the two second recesses **228** by means of the two second engaging hooks **48**. Therefore, the two roller brushes **14** are connected to the body **11** by means of the roller brush frame unit **13**. The conductive elements **74** of the driving portion **70** of the roller brush frame **30** abut against a resilient conducting element (not shown) and thereby connect electrically to a power device (not shown) disposed inside the body **11** by means of the two resilient conducting elements. The dust-sucking and dust-collecting apparatus **12** is disposed between the inner surfaces **421** of the two vertical plates **42** of the connection frame **40**. An inlet (not shown) of the dust-sucking and dust-collecting apparatus **12** is in communication with the through holes **423**, **623** of the connection frame **40** and the roller brush frame **30**, respectively. During the process of operation of the autonomous coverage vacuum cleaner **10**, the roller brushes **14** are in contact with the floor and sweep dust and debris into the through holes **423**, **623** by driving the dust and debris to drift along the inclined surface **642** of the guiding member **64**, such that the dust and debris is sucked into and collected by the dust-sucking and dust-collecting apparatus **12**.

More importantly, if the autonomous coverage vacuum cleaner **10** works on an uneven floor or is confronted with an obstacle, such as the edge of a carpet, an external force exerted by the floor or the obstacle on the roller brushes **14** will be indirectly transmitted to the roller brush frame **30**. With the roller brush frame **30** being capable of moving vertically relative to the connection frame **40** and the body **11** because of the resilience of the resilient connection element **50**, the roller brushes **14** lift and drop in order to fit the uneven surface of the floor. Therefore, the roller brushes **14** can not only pass an obstacle easily but also clean it thoroughly. Hence, the roller brush frame unit **13** enables the roller brushes **14** of the autonomous coverage vacuum cleaner **10** to lift and drop resiliently and automatically according to the condition of the floor and enhances the passage and cleaning performance of the autonomous coverage vacuum cleaner **10**.

The constituent elements disclosed in the above embodiments of the present invention are illustrative of the present invention only, but should not be interpreted as restrictive of the scope of the present invention. Hence, replacements or variations of other equivalent elements should be covered by the claims of the present invention.

What is claimed is:

1. An autonomous coverage vacuum cleaner having a roller brush capable of resilient vertical displacement, comprising:

a body;

a roller brush frame unit comprising a roller brush frame, a connection frame, and a resilient connection element, the connection frame being disposed at a bottom of the body, and the resilient connection element being con-

nected between the roller brush frame and the connection frame and being configured such that the roller brush frame moves vertically relative to the connection frame and the body when subjected to an external force; and

at least one roller brush rotatably disposed at the roller brush frame,

wherein the roller brush frame and the connection frame each have at least one vertical plate, the vertical plate of each of the roller brush frame and the connection frame having an outer surface, an inner surface, and a through hole penetrating the outer surface and the inner surface,

wherein the outer surface of the at least one vertical plate of the roller brush frame and the outer surface of the at least the vertical plate of the connection frame face each other, and

wherein the resilient connection element is adhered and fixed to inner sidewalls of the through holes, the inner surfaces, and the outer surfaces of the at least one vertical plate of the roller brush frame as well as inner sidewalls of the through holes, the inner surfaces, and the outer surfaces of the at least the vertical plate of the connection frame.

2. The autonomous coverage vacuum cleaner of claim **1**, wherein the body has a bottom board, the bottom board having an upper surface, a lower surface, at least one recess formed on the upper surface, and at least one groove penetrating the upper surface and the lower surface and communicating with the recess, wherein a top portion of the connection frame has at least one engaging hook penetratingly disposed at the at least one groove of the bottom board and engagedly disposed at the at least one recess of the bottom board.

3. The autonomous coverage vacuum cleaner of claim **2**, wherein the bottom board of the body has a central area and an edge, wherein the at least one recess of the bottom board comprises a first recess disposed at the central area and two second recesses disposed at the edge, wherein the at least one groove of the bottom board comprises a first groove disposed at the central area and two second grooves disposed at the edge, the first recess being in communication with the first grooves, and the two second recesses being in communication with the two second grooves, respectively, wherein the at least one engaging hook at the top portion of the connection frame comprises a first engaging hook and two second engaging hooks, the first engaging hook being penetratingly disposed at the first grooves and engagedly disposed at the first recess, and the two second engaging hooks being penetratingly disposed at the two second grooves, respectively, and engagedly disposed at the two second recesses, respectively.

4. The autonomous coverage vacuum cleaner of claim **3**, wherein the connection frame has two vertical plates each having the outer surface, the inner surface, and the through hole penetrating the outer surface and the inner surface, wherein the two vertical plates join each other by an end thereof to form a joint portion, the first engaging hook being disposed at the joint portion, and the two second engaging hooks being disposed at the two vertical plates, respectively.

5. The autonomous coverage vacuum cleaner of claim **4**, wherein the at least one roller brush comprises at least two roller brushes, and the roller brush frame has two receiving portions each having a receiving space for receiving therein one of the at least two roller brush, the two receiving portions each having the vertical plate, the vertical plate having the outer surface, the inner surface, and the through hole penetrating the outer surface and the inner surface, the inner surface facing the receiving space of a corresponding one of the receiving portions, wherein the outer surfaces of the vertical plates of the roller brush frame face the outer surfaces of the vertical plates of the connection frame, respectively, wherein the resilient connection element is adhered and fixed to the inner sidewalls of the through holes, the inner surfaces, and the outer surfaces of the vertical plates of the roller brush frame as well as the inner sidewalls of the through holes, the inner surfaces, and the outer surfaces of the vertical plates of the connection frame.

6. The autonomous coverage vacuum cleaner of claim **1**, wherein the roller brush frame has a driving portion for driving the at least one roller brush to rotate, the driving portion having a top surface and two conductive elements exposed from the top surface.

7. The autonomous coverage vacuum cleaner of claim **6**, wherein a guiding member is disposed at a bottom of the roller brush frame and has an inclined surface facing the at least one roller brush, wherein the inclined surface tilts toward the at least one roller brush in a top-down direction.

8. The autonomous coverage vacuum cleaner of claim **1**, wherein a guiding member is disposed at a bottom of the roller brush frame and has an inclined surface facing the at least one roller brush, wherein the inclined surface tilts toward the at least one roller brush in a top-down direction.

* * * * *